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VICTORY OVER THE DANGEROUS DISEASES OF MAN AND ANIMALS

[This is a translation of an article written by Prof. G. S. Pervomayskiy and Prof. V. Ya. Podolyan in Priroda (Nature), No 2, Moscow, 1960, pages 33-38.]

Military Medical Academy imeni S. M. Kirov (Leningrad)

The teaching of natural nidi of diseases of man is one of the most outstanding achievements of Soviet biology and medicine. This teaching was first exposed by Academician Ye. N. Pavlovskiy in 1938. Subsequently it has been continuously enriched by new data and has received wide recognition not only in the Soviet Union but also abroad.

Geography of "Mysterious" Diseases

The idea of the existence in various regions of our country of natural nidi of transmissible and parasitary, i.e., carried by parasites, diseases was not born at once: its emergence was preceded by years of painstaking study of the geographic distribution of bloodsucking arthropoda -- carriers of the causative agents of infections and invasions -- studies of the biology and ecology of the alimentary (food) connections of the carriers, clarification of the probable ways of their infection and their transmission of the infectious source.

The "mysterious" diseases among the population of various territories in the form of isolated cases or extensive outbreaks have been known for a long time, but long remained unrecognized. An illustration is the oriental sore [Aden ulcer] which afflicted everyone who came for the first time to its endemic nidi. Mass epidemics of the so-called "summer Grippe" on the southern Crimean sea coast which had been observed toward the end of the 19th and the beginning of the 20th centuries deprived people of their work capacity from 15 to 20 days. In the steppe regions of the Far East and Siberia diseases were observed resembling mild forms of typhus fever which now belongs to history. Their origin was connected with the visitation of places abundant with Ixodes ticks. This grave disease of the central

nervous system had a high mortality rate and often led to non-reversible paralysis. It was observed in the tayga zone of the Far East and, later, also in other forest regions. All these diseases were distinguished by territorial peculiarity, seasonal characteristics, and the absence of contagiousness (infection upon contact). Not infrequently they afflicted people who worked far from populated places, even in places where human beings had never been before. The study of the clinic, etiology, epidemiology, and prevention of these "mysterious" diseases requires the concentration of efforts of medical workers, zoologists, parasitologists, botanists, and representatives of many other specialities.

Scientific Feat

The great and universally recognized merit of the Academician Ye. N. Pavlovskiy was the organization of over 200 expeditions which embraced in their activity the republics of Central Asia, Transcaucasia, Far East, Zabaykalye, Siberia, central and northwest regions of the RSFSR, Crimea and Zakarpat'ye.



Ruins of adobe buildings which serve as retreat for ticks -- carriers of tick relapsing fever.

Many expeditions were of a complex character; their participants were associates of the Military Medical Academy imeni S. M. Kirov, Academy of Medical Sciences USSR, Zoological Institute of the Academy of Sciences USSR, and workers of local medical institutions. During the works of the expedition the attention of Ye. N. Pavlovskiy and his students was invariably attracted to

the study of natural nidi and the prevention of most dangerous and widespread diseases.

What is a natural nidus?

The immense material accumulated through the work of many years by expeditions on species-composition, distribution, biological and ecologic characteristics, and symbiotic bonds of the bloodsucking insects and parasitic ticks with their hosts -- the wild mammalia and birds -- parallel with the studies of natural infectiousness of carriers served as a strong basis for teaching the natural nidi of transmissible and parasitic diseases. Such a natural nidus represents a territorial segment of a definite geographic landscape (desert, semidesert, steppes, taygas) on which, under the influence of favorable environmental factors, unique interrelations were formed in the evolutionary process between the causative agent of the disease, the animal-donors, the recipients (hosts) of the causative agent, and the carriers.

The carriers, feeding on the blood of the infected wild animals, receive from them the causative agent and transmit it in the process of subsequent bloodsucking to new recipients. Thus, a circulation of the causative agent takes place between the carriers and their hosts. In some cases the causative agent present in the animal organism leads to a disease -- in others -- to a symptomless carrying.

The natural-nidi diseases are zoonoses, i.e., infections affecting animals as well as humans. Their continuous existence and relationship to a definite territory is explained by many factors. Thus, of great significance is the ability of the causative agent to be preserved in the carrier's organism, to multiply, and to reach the state in which he can infect animals and humans. The causative agent may be secreted from the carrier's body with saliva, fecal masses, or cavity fluid during a mechanical injury to the carrier himself. In many instances, the carrier apparently does not suffer from the presence of the causative agent. Moreover, the causative agent seems to be able to penetrate into the ovarian cells of the female carrier which leads to infection of the ovaries and emergence of an infected progeny. Such a transmission of the causative agent may spread not only to the daughter-progeny but also to other descending generations of the carrier. The territorial limitation of natural nidi is connected with the area (region) of distribution of given carriers and animal donors of the causative agent. Knowing this, one can suspect beforehand the

unsanitary state of certain localities on the basis of some natural-nidus disease and undertake in time the necessary preventive measures.

When an individual happens to be in such a locality, he can be subjected to the disease only upon combination of the following conditions: there must be present in the locality hungry carriers infected with the causative agent and capable of attacking humans; the individuals which enter the natural nidi of the disease must not be immune (not susceptible) to the causative agent or the disease itself. The infection of people becomes possible upon the introduction of causative agents by the carriers in a virulent (active) state and in a dose sufficient for the development of the disease.

In the nidi of transmissible diseases the population, which lives there constantly, apparently acquires immunity as a result of frequent contact with the carriers and the introduction of a mildly virulent virus or of small doses of the virus. On the other hand, individuals entering the territory of natural nidus for the first time are particularly susceptible.

The teaching of Acad. Ye. N. Pavlovskiy on natural nidi is thoroughly substantiated factually as well as methodologically; it is fully applicable to the scientific and practical problems of public health. Its significance is well illustrated by the following examples.

In many regions of Central Asia and the Transcaucasus physicians observed isolated cases of the so-called quinine-resistant forms of malaria which proceed in protracted, relapsing, recurrent attacks. The true nature of these cases was revealed by Ye. N. Pavlovskiy and his associates who relegated it to a form of disease, new in our country -- tick relapsing fever. The carriers of the causative agents of this disease -- spirochetes -- turned out to be the ticks of ornithodoros species. Upon sucking the infected blood of wild mammalia by ticks, the spirochetes enters the organism of ticks, penetrate via the intestinal canal into the body cavities, and go through definite phases of development. They are accumulated in the salivary and genital glands and in other organs of ticks. The infected ticks retain the spirochetes during their entire life, which may last from 20 to 25 years. Nymphs (pupae) of higher age and adult ticks are capable of surviving for from 5 to 13 years, but the spirochetes in this case do not lose their pathogenicity. The spirochetes are transmitted from the infected female ticks to their daughter and granddaughter generations via father.

Spirochete Carriers and Transmitters

The spontaneous spirochete-carrying by wild animals -- lamella-dental rat, gerbil, porcupine, bats, steppe-tortoise, and many others -- leads to infection of the Ornithodoros species of ticks which feed on them. The tick spirochete-carriers, in turn, serve as a source of spirochetosis infection of animal hosts and as a stable reservoir of viruses under natural conditions. The circulation of spirochetes between the ticks and wild animals ensures the continuous existence of nidi of tick relapsing fever in the desert and semidesert territories of dry subtropical regions, even in the absence of humans and domestic animals. The resistance of ticks to prolonged starvation, the transmission of spirochetes through the father, and their transition from one phase of tick development to another contributes to the maintenance of nidi of tick spirochetosis.

Ticks of the Ornithodoros species are active also in their attack on humans which are very susceptible to tick spirochetosis. Ticks attach themselves by suction to humans and transfer, via saliva, the spirochetes into their blood.

Certain species of Ornithodoros ticks exist exclusively in wild nature; other species transported into the adobe farm buildings of humans find there the needed conditions for life and proliferation in feeding themselves on the blood of domestic animals. This circumstance leads to the formation of farming or anthropurgic nidi of tick relapsing fever which exist parallel with the natural ones. Such nidi, containing a considerable concentration of carrier ticks, may assume a more important epidemic significance than the natural nidi of this disease. The knowledge of laws of maintenance of these as well as other nidi of tick spirochetosis made possible the development of effective preventive measures for the protection of humans from infections.

Tick Fevers of the Typhus Exanthematous Type

Ye. N. Pavlovskiy expressed an idea of the possibility of the existence of tick fevers of the typhus exanthematous type on the territory of the USSR. In a little less than two years there were discovered in Sevastopol' authentic cases of Marseilles exanthematous fever diseases and the importance of canine tick in the transmission of rickettsiae -- the causative agents of this disease -- was proven. Later, similar isolated instances of the disease took place on the



Academician Ye. N. Pavlovskiy (left) and
Prof. V. D. Solov'yev (right) in the
Expedition Virological Laboratory



A hand with multiple affections of the
Oriental sore

Black Sea-Caucasian shore and in Azerbaydzhan. Further investigations led to the discovery of natural nidi of tick exanthemaous-like fevers in Siberia, Zabaykal'ye, in the Far East and in Kazakhstan. The nidi of these fevers are located predominantly in the steppe territories where the Ixodes (pasture) ticks of the derma-ceptor and hemaphysalis species are prevalent. The causative agents of tick exanthematous-like fevers -- Rickettsiae -- remain for long periods of time in the body of ticks, proliferate in the cells of their internal organs, enter the salivary glands of the parasites, and are transmitted by the infected females through their ovaries to four or five descending

generations of ticks. The Ixodes ticks are infected by rickettsiae from wild rodents and contaminate fresh animals by sucking their blood.

The infection of humans by tick exanthematous-like fevers is connected with the invasion of carrier-ticks which introduce rickettsiae into the blood with their saliva. The separation of these diseases into an independent form enabled us to work out special means of their prevention and treatment. There is no doubt that natural nidi are also characteristic of Q-fever the causative agent of which may be transmitted not only through carriers but in some other ways as well.

Tick Encephalitis

The works of Ye. N. Pavlovskiy and his associates which deserve special attention are the ones on the natural nidi of tick (spring-summer) encephalitis which had been isolated as a separate disease in 1935 but remained unexplored concerning its etiology, epidemiology, clinical manifestations, and prophylaxis until special expeditions were organized to the nidi of the disease in the Far East. The first expedition in 1937 headed by Prof. L. A. Zil'ber was very fruitful and laid down the foundation for extensive studies of the problem of tick encephalitis as a whole. In heading the second complex expedition of the Narkomzdrav USSR in 1938 and the parasitological works in subsequent years, Ye. N. Pavlovskiy introduced into this work a great deal of his personal effort and initiative which ensured the high scientific level of studies. The isolation from Ixodes ticks of the tayga fauna of a filtrable neurotropic (selectively affecting the nervous system) virus, identical in properties to the virus stains isolated from the brain of people who had died of encephalitis, left no doubt that ticks are precisely the basic source of the natural spread of the infection. Extensive studies were initiated to clarify the susceptibility of wild animals-feeders of Ixodes ticks to experimental infection with encephalitis virus and the elicitation of their spontaneous virus-carrying capacity. Simultaneously studies were carried out on the natural infectibility of Ixodes ticks with the virus at various phases of development.

The isolation of many virus stains from wild rodents, insectivorous and Ixodes ticks, and the data of epidemiological observations led Ye. N. Pavlovskiy to the conviction of the natural nidi character of tick encephalitis. Special explorations were organized by him in the uninhabited

Ussurina tayga where he invariably succeeded in isolating virus stains from wild mammalia, ticks, and, later, from birds. It became clear that the nidi of tick encephalitis had been initially formed in natural environments by circulation of the virus between ticks and wild animals. Other factors which contributed to the formation and maintenance of such nidi were the prolonged preservation and proliferation of the virus in the body of the carriers, transmission of the virus via ovaries of the infected tick females to their progeny, and the preservation of the virus in the process of metamorphosis and during the winter hibernation of ticks.

The accumulation of the virus in the carrier's salivary glands ensures its entry into the body of the animal hosts during the bloodsucking by ticks. The virus is introduced in a similar manner into the human organism by the ticks.

The ascertaining of natural nidi of tick encephalitis in the tayga zone of the Far East, the detailed description of their fauna, flora, and symbiosis served as a stimulus to the study of the geographic distribution of this disease in our country. It is known now that the nidi of tick encephalitis are scattered over the entire territory of the tayga-forest zone of the USSR, which extends from the shores of the Pacific Ocean to the Baltic sea and further west. Frequently these nidi are found even in the vicinity of large populated points, provided there are areas of nearly virgin forest with carrier-ticks, and animal donors and recipients of the virus.

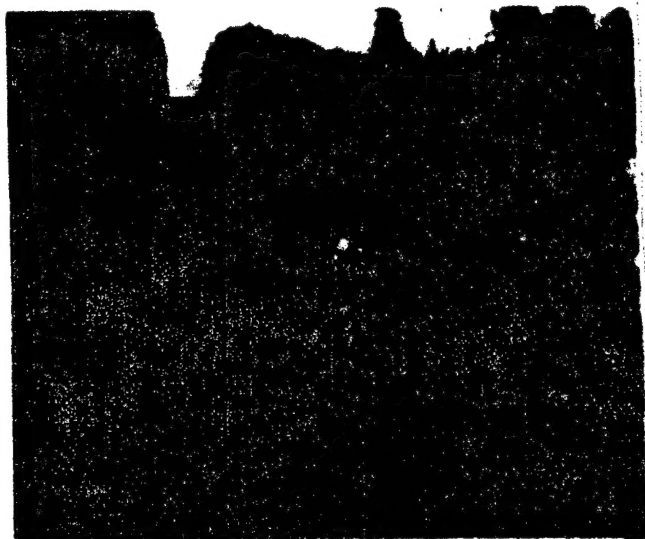
Another important event was the isolation of a second clinical variant of the disease which proceeds along the type of a two-wave meningo-encephalitis, and the proof of infection of people as a result of consuming fresh goat's milk containing the virus. It turned out that man can become infected not only through bites of Ixodes ticks but also by way of food. On the basis of the teaching of natural nidi of tick encephalitis, effective means were developed of combatting ticks; these measures ensure, parallel with seroprophylaxis and vaccination, a reliable antiepidemic effect.

The Mystery of "Pendinka" [Oriental Sore]

For many years the epidemiology of Borovskiy disease (pendine ulcer) with which, almost without exception, the entire population of the Central Asia oases is afflicted, remained a mystery. Only during Soviet time did the

associates of Academician Ye. N. Pavlovskiy conduct special studies in the deserts of Turkmenia which elicited the basic epidemiological characteristics of this skin disease. It turned out that the predominant localities of the habitat of mosquitoes -- carriers of leishmaniasis, the causative agents of this disease -- are in hot deserts in the burrows of wild rodents, gerbil and gophers which live in colonies. They make their burrows at a 1.5 to 2 meter depth, where subtropical climate conditions prevail during the entire year and are favorable for a continuous proliferation of mosquitoes. Winged mosquitoes feed on the blood of the gerbil, become infected with leishmaniae which multiply in their stomach. When such mosquitoes suck blood, the infection of healthy animals with leishmaniasis takes place. Thus, the gerbil burrow proves to be the elementary nidus where the peculiar exchange of leishmaniae between their steady hosts and the mosquitoes takes place. An analogous phenomenon takes place also in gophers' burrows. Only with the discovery of the natural nidi of the Bobrovskiy disease the control of it was placed on a scientific basis.

Hemorrhagic fevers, i.e., diseases accompanied by internal hemorrhages, the study of which has made notable progress during the past decade, also represent natural-nidi diseases in the majority of instances. Hamazid ticks, fleas, and other bloodsucking arthropoda -- ectoparasites of warmblooded animals -- apparently participate in the virus circulation of other local forms of hemorrhagic fevers.



Nidus of a tularemia infection.

Diseases Caused by Bacteria

In addition to diseases caused by ultra-viruses and rickettsiae, the teaching of natural nidi retains its value in regard to a number of infections of bacterial nature: plague, tularemia, and listerellosis. The principal carriers of the plague causative agents are the desert and steppe species of rodents; they infect the common parasites of rodents -- fleas -- in the stomach of which the plague microbes live from three to four months and longer. By multiplying intensively they form a jelly-like plug which seals the digestive tract of the insect. Such "blocked" fleas are distinguished by their special need for blood--sucking, but the fresh portions of blood entering the front part of the intestines wash away the plug partially and, by the force of a reverse thrust carry off the microorganisms into the wound at the seat of the insect's puncture. Such is the basic mechanism of plague infection through fleas. The plague microorganisms are also excreted into the external medium with the flea's feces. In addition to fleas -- lice of rodents, Ixodes, and hamazid ticks are included in the infection link.

The natural nidi of plague are of very ancient origin; they are maintained on definite territories of semiwild and wild nature which serve as natural areas of wild rodents, carriers of plague microorganisms, and fleas which also are infection carriers.

The Soviet researchers also deserve the credit for the thorough study of natural nidi of tularemia, a disease which spreads by infected water, food products, infected rodents, air, and carriers. The bloodsucking arthropoda, during the season of their activity, play an important role in the tularemic nidi by spreading the infection among animals and by transmitting the disease-causing agent to humans. Mosquitoes, bloodsucking flies, and horseflies are distinguished by their property of limited mechanical transmission of the tularemia causative agent by means of their oral organs; others, Ixodes ticks, for example, preserve the microorganisms in the intestines for long periods of time.

Listerellosis is also distinguished by its natural nidi. The exchange of listerellae in the natural nidi is effected between the rodents and Ixodes ticks. There are known listerellosis nidi where domestic animals serve as carriers of the causative agents and the basic source of infection of humans. Apparently, the formation of such nidi is a secondary phenomenon.

In regard to helminthes invasions on the territory

of the USSR, the natural nidi are characteristics of trichinellosis, echinococcosis, and diphyllbothriosis. Human or domestic animal participation in the preservation of the causative agents in all these diseases is not essential.

* * *

The above-cited examples do not by any means exhaust the list of diseases with natural nidi. With the mastering of new territories and analysis of various forms of diseases, science undoubtedly will be enriched with new data which will illustrate the vital value of the teaching of Academician Ye. N. Pavlovskiy.

END